USDA Forest Service
Tonto National Forest
Arizona

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Process Memorandum to File

Annual Greenhouse Gas Emissions

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Purpose of Process Memorandum

The purpose of this process memorandum is to provide the background and summary of the total direct and indirect emissions of greenhouse gases (GHG) associated with the proposed action for the Resolution Copper Mine (RCM) Development near Superior, Arizona.

Key Process Steps

The calculation of total GHG emissions involves determination of direct GHG emissions from (1) total annual fuel use, generally diesel fuel and propane, for on-site sources and equipment, (2) the incorporation of established emission factors for each GHG, and (3) an adjustment for total global warming potential for each GHG constituent.

Indirect GHG emissions are calculated for transportation of the copper concentrate to off-site processing facilities and off-site electric power generation from the utility suppler, that supports the on-site electric power demand.

Direct Greenhouse Gas Emissions from RCM

Greenhouse gas (GHG) emissions from fuel combustion for RCM were calculated and included in Appendix A of the NEPA Modeling Report (Air Sciences, 2019). That tabulation showed a total GHG emission rate of approximately 173,000 metric tonnes of CO_2-equivalen emissions (CO_2e) per year. Air Sciences (2019) provided further details of direct GHG emission calculations based on projected RCM fuel use, established emission factors for diesel and propane, and an adjustment to total carbon dioxide-equivalent (CO_2e) rates. The GHG emission for this analysis included the emissions of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). The proposed action and preferred alternative would generate GHG from on-site fuel combustion from mobile equipment, heat combustion sources, backup generators, and heavy construction equipment.

Data for GHG emission factors were taken from 40 CFR 98 Tables A-1 and C-1 for propane and diesel combustion, using total fuel combustion.

- CO_2 emission factors are 73.96 kg per million Btu (MMBtu) for diesel and 61.71 kg/MMBtu for propane combustion
- CH_4 emission factors s are 0.003 kg/MMBtu and N2O emissions are 0.0006 kg/MMBtu for both fuels.
- CO2-equivalents (CO_2e weight factors, or global warming adjustments) are 1 for CO_2, 25 for CH_4, and 295 for N_2O in accord with Table A-1 of 40 CFR 98.

The following table, extracted from Air Sciences (2019) Appendix A, provides a summary of GHG emissions from the various components of the proposed action.

Propane Fuel Use & Direct GHG Emissions

Contributor	MMBtu/hr	hr/yr	MMBtu/yr	CO_2 tonne/yr*	CH_4 tonne/yr*	N_2O tonne/yr*
Hydro House Heaters	0.11	8,760	964	59.5	2.9E-3	5.8E-4
Total			**964**	**59.5**	**2.9E-3**	**5.8E-4**

**metric tons per year*

Diesel Fuel Use & Direct GHG Emissions

Contributor	Diesel Cons. gal/yr	+15% gal/yr	MMBtu/yr	CO_2 tonne/yr**	CH_4 tonne/yr**	N_2O tonne/yr**
East Plant Fleet	2,345,797	2,697,666	369,580	27,334	1.1	0.22
West Plant Fleet	741,883	853,166	116,884	8,645	0.35	7.0E-2
Loadout Fleet	555,866	639,246	87,577	6,477	0.26	5.3E-2
Tailings Fleet	9,322,392	10,720,751	1,468,743	108,628	4.4	0.88
East Plant Emergency Generators	1,643,748	1,890,310	258,973	19,154	0.78	0.16
Mil Emergency Generators	55,500	63,825	8,744	647	2.6E-2	5.2E-3
Tailings Emergency Generators	18,500	21,275	2,915	216	8.7E-3	1.7E-3
Filter Plant Emergency Generators	18,500	21,275	2,915	216	8.7E-3	1.7E-3
Railroad	116,693	134,197	18,385	1,360	5.5E-2	1.1E-2
Total	**14,818,879**	**17,041,711**	**2,334,714**	**172,675**	**7.0**	**1.4**

**Calculated by mass balance using a 15% fuel contingency*

***metric tons per year*

Direct CO_2e Emissions

Greenhouse Gas	Emissions tonne/yr*	Global Warming Potential**	CO_2e tonne/yr*	
Carbon Dioxide (CO_2)	172,735	1	172,735	
Methane (CH_4)	7.0	25	175	
Nitrous Oxide (N_2O)	1.4	298	418	
Total			**173,328**	**direct emissions > 25,000 metric tons per year**

The basic emissions from fuel sources involves calculating the total fuel use for each set of components, including the individual fleet vehicles at each site. Note that the fleet vehicle emissions dominate the GHG emission inventory. Those fleet calculations include the estimated unit horsepower, number of units, and annual hours of operation. In addition, the calculated fuel use included a conservative estimated further adjustment (increase) of 15% for the calculated value. As noted in the table above, the total annual GHG emissions, which are for year 14, the maximum production and operation period, are 173,328 metric tonnes of CO_2e.

Fleet vehicle GHG emissions account for approximately 87 percent of the total. However, for this source group, the total tabulated CO_2e emissions in Air Sciences (2019) were not adjusted for "load factor" for diesel-fired engines as provided in Appendix A (cited above), and the analysis double-applied an adjustment of 15% to fuel use. If such an adjustment were to be applied, a revised calculation of the total would drop to about 51 percent of the total GHG for this fleet vehicle group, resulting in an estimated total RCM CO_2e emissions of approximately 98,600 tonne/year, or about 57 percent of the referenced total annual GHG emissions. Nevertheless, as a conservative approach, and for comparison, the value of 173,000 metric tonnes is retained for analysis.

Indirect GHG Emissions

1. Shipping Copper Concentrate to Smelters

Data from the Draft EIS state that "During the Operation Phase, between 6,000 and 7,000 wet tons per day of copper concentrate would be produced and sent out for smelting at an off-site location." Using 7,000 tons/day for 365 days per year would lead to shipping 2.56 million tons per year, which would be used to estimate the maximum shipping requirement for assessing GHG emissions.

The calculation of indirect GHG emissions for shipping is based on a combination of data assumptions, beginning with calculating a greenhouse gas emission factor for shipping bulk materials by rail. The American Railroad Association indicates that in general railways move 1 ton for freight a distance of 470-473 miles per gallon of (diesel) fuel[1]. Diesel fuel has about 135,000 Btu per gallon. Emission factors for greenhouse gases from diesel firing are provided above. As a result, 1 gallon of diesel fuel (0.135 MMBtu/gallon) X (74.18 kg CO_2e / MMBtu) is 10 kg of CO_2e/gallon, or 0.01 metric tonne per gallon. The resulting emission factor is (0.01 tonne CO_2e/gallon)*(1 gallon/ 470 ton-mile) = 2.128×10^{-5} tonne CO_2e/ ton-mile shipping.

This analysis assumes and compares GHG emissions from shipping the copper concentrate to two destination, Salt Lake City, Utah, and Shanghai, China. The distance for shipping by rail is extracted from an on-line calculation provided by Burlington Northern Railway[2]. The following results were obtained.

- Phoenix to Salt Lake City 1,474 rail miles
- Phoenix to Los Angeles Harbor 517 rail miles.
- Each calculation will add an additional 60 miles for shipping from the Filter Plant and Loadout Facility to Phoenix.

The calculation for total shipping to these destinations is as follows

- Phoenix to Salt Lake City (1,534 miles) X (2,560,000 tons) X (2.128×10^{-5} tonne CO_2e/ ton-mile) = 83,000 tonne
- Phoenix To LA Harbor (577 miles) X (2,560,000 tons) X (2.128×10^{-5} tonne CO_2e /ton-mile) = 31,200 tonne

For ocean shipping from Los Angeles Harbor to China (Shanghai) the distance is 6,469 miles (5,630 nautical miles (nm). Calculated ocean shipping CO_2e for bulk carrier is based on 2013-2015 data[3].

[1] https://railroads.dot.gov/rail-network-development/freight-rail-overview
https://www.aar.org/wp-content/uploads/2018/07/AAR-Railroads-Greenhouse-Gas-Emissions.pdf
https://www.climate-chance.org/wp-content/uploads/2019/03/new-greenhouse-gas-emissions-a-decisive-asset-for-rail.pdf

[2] http://www.bnsf.com/bnsf.was6/RailMiles/RMCentralController

[3] https://theicct.org/publications/GHG-emissions-global-shipping-2013-2015

The raw data for GHG Emissions for ocean shipping with bulk carriers uses the totals presented in that report to calculate an emission factor for GHG shipping (CO_2e/ton-nautical mile). The average GHG emission rate for the three years is 4.21 g of CO_2e per ton-nautical-mile of bulk shipping.

The distance from Los Angeles to Shanghai = 6479 miles = 5630 nm. The calculation of total GHG emissions associated with ocean shipping is 60,600 tonnes CO2e for bulk shipping of 2.56 million tons from Los Angeles to Shanghai.

2. Off-site Power Generation

As stated in the EIS, Salt River Project would be the utility that would provide electric power.
From the Load Impact Study[4]: *The total maximum combined load proposed by RC is 273 to 315 MW.*

GHG (CO_2) calculations can be based on available efficiency for Arizona and proposed efficiencies at a later date. Data for CH_4 and N_2O are not available from these documents, but are likely negligible compared to the total CO_2 emissions.

- A 2018 survey for Arizona showed 919 lbs. CO_2/MWh.[5]
- Current Baseline is 1086 lb/MWh
- SRP commits to 700 lbs. CO_2/MWh by 2035 (SRP report to stakeholders)[6]

The calculation of total annual GHG emissions for off-site electric power generation is as follows

- RCM use averages 315 MW X 8760 hours = 2.76 $\times 10^6$ MWh
- At baseline for SRP: 1086 lb/MWh X 2.76 $\times$ 10^6 MWh /2200 lb/tonne (Metric tonne) = 1,362,000 tonne CO_2
- At projection for 2035: 700 X 2.76 x 10^6 / 2200 = 878,000 tonne CO2e.

Resolution has also taken certain actions to offset a portion of the greenhouse gas emissions. In November of 2019, Resolution Copper Mining LLC entered into a Solar Participation Agreement with the Salt River Project Agricultural Improvement and Power District to obtain solar power from a solar photovoltaic generating facility expected to go online in January of 2022. In furthering its promise to increase its reliance on renewable energy, Resolution subscribed to 4.6% of the generating facility's solar power. Accordingly, by entering into the agreement, Resolution has sourced Renewable Energy Credits constituting approximately 25% of Resolution's estimated baseload in 2022. Resolution will continue to explore other opportunities to obtain Renewable Energy Credits as the project moves forward and in line with Rio Tinto's climate change initiatives. Rio Tinto has plans to invest $1 billion over the next five years to support delivery of its climate change targets and company objectives for net zero emissions from operations by 2050 as noted on the RT website and press release in business wire.[7]

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[4] Salt River Project, 2020: Resolution Copper Load Impact Study, Final 2/20/20
[5] https://www.eia.gov/electricity/state/Arizona/
[6] SRP 2035 Community Stakeholder Engagement Summary Report. APRIL 3, 2019 KIM HARTMANN, KCH SOLUTIONS LLC, FACILITATOR & REPORT AUTHOR
[7] (https://www.riotinto.com/sustainability/climate-change and https://www.businesswire.com/news/home/20200226005549/en/).

3. Summary Totals

The following table provides a summary of total GHG Emissions (ton/year CO_2e) for separate options for processing and smelting locations. All data in tonne CO_2e/ year

Total Annual Greenhouse Gas Emissions (Tonne) for shipping/processing options.

Option	Direct	Rail	Ocean	Electric	Total
Salt Lake City	173,000	83,000		878,000	1,134,000
Shanghai	173,000	31,200	60,600	878,000	1,142,800

CEQ Guidance

Guidance from the Council on Environmental Quality (CEQ) characterizes the analysis for Climate change and cumulative analysis. Under this guidance a qualified comparison to other regional sources is warranted for information purposes and disclosure of comparative impacts regarding alternatives; however, a global separate cumulative effects analysis is not required.

From CEQ guidance: Where GHG inventory information is available, an agency may also reference local, regional, national, or sector-wide emission estimates to provide context for understanding the relative magnitude of a proposed action's GHG emissions. SRP's peak demand in 2019 was 7,305 MW. The total maximum combined maximum load proposed by RCM (315 MW, as noted above) represents 4.3% of that peak demand. Total Arizona net electric power summer peak capacity for 2018 was 28,672 MW[8]. The RCM demand would be about 1.1% of that total statewide capacity.

The CEQ approach, together with a qualitative summary discussion of the effects of GHG emissions based on an appropriate literature review, allows an agency to present the environmental impacts of a proposed action in clear terms and with sufficient information to make a reasoned choice among the alternatives. A review of GHG Emissions from the alternatives (Air Sciences, 2019) shows that there is less than a 1% change in emissions of CO_2e between the proposed action (Alternative 2) and the recommended alternative (Alternative 6). This difference does not warrant a strong case for selected one alternative versus another based on the GHG emissions.

This discussion satisfies NEPA's requirement that agencies analyze or compare the effects of a proposed action and avoid a cumulative impact analysis because the potential effects of GHG emissions are inherently a global feature.

[8] US Energy Information System, 2019. Arizona Electricity Profile 2018. https://www.eia.gov/electricity/state/Arizona/

References

Air Sciences, 2019.*Resolution Copper Project NEPA Air Quality Impacts Analysis*. Prepared for Tonto National Forest Project. No.262. Denver, Colorado: Air Sciences Inc. February 2019.